2007 RESEARCH PROBLEM STATEMENT

Problem Title: Improved Stability and Consolidation Assessment of Embankments **No.:** UT07.7-04

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Project Champion: James Higbee

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.

The current method of assessing embankment and foundation stability used by UDOT and its designers is based on total stress concepts and undrained shear strength theory. However, such methods do not couple pore water pressure generation with the consolidation process and account for shear strength gain due to pore pressure dissipation in finely bedded soils, such as the Lake Bonneville sediments.

For rapid construction on soft soils, especially where PV drains are used, it is important to estimate and account for the initial excess pore pressure generation from the embankment loading(s), the rate at which excess pore water pressure dissipates and the subsequent degree of consolidation and the associated gain in shear strength. These factors are necessary to evaluate the factor of safety against potential foundation failure and/or the rate of safe fill placement. Such an approach requires a fully-coupled effective stress soil model that inherently accounts for consolidation and shear-induced pore pressures and their affect on stability.

This research proposes to develop the laboratory test procedures, requisite soil properties, in situ techniques, analysis and evaluation approach, and construction monitoring program to implement fully-coupled effective stress evaluations for consolidation and stability assessments of UDOT embankments constructed atop soft foundation soils.

The proposed research is an extension of on-going research at the U of U, which has focused on developing laboratory and in-situ techniques for estimating the consolidation behavior and properties of the Lake Bonneville Clays. The U of U research has already developed laboratory consolidation test procedures (controlled-rate-of-strain) and in-situ methods (CPT and DMT) to evaluate key compressibility and permeability parameters of the Lake Bonneville Clay. This previous research is essential for the successful effective stress assessment and modeling of these clays.

2. Strategic Goal: ☐ Preservation ☐ Operation ☒ Capacity ☒ Safety (check all that apply)

3A. List the research objective(s) to be accomplished:

1. Recommend appropriate full-coupled soil models to UDOT for fully-coupled effective stress analyses.
2. Develop triaxial test program and procedures to obtain the required soil parameters for a preselected site.
3. Develop correlations with selected soil parameters so that in situ tests can also be used to estimate key model parameters.
4. Validation of approach with existing field/project observations (e.g., I-15 Reconstruction and Legacy Highway Projects).
5. Develop methods/recommendations for safe rates of embankment placement.
6. Recommend the type and amount of instrumentation that should be used to monitor future embankment construction and validate the coupled-effective stress evaluations.

3B. List the major tasks to accomplish the research objective(s): **Estimated person-hours:** 1200

1. Review literature and summarize available fully-coupled effective stress soil models.
2. Select with TAC, the soil model most applicable to UDOT needs, laboratory test equipment and prior U of U research efforts.
3. Select with UDOT, the potential locations/projects for performing the field investigations.
4. Perform field investigations, including in situ testing, undisturbed sampling of soil and installation of construction performance monitoring
5. Perform laboratory testing to obtain key soil parameters for selected soil model
6. Develop correlation of laboratory obtained soil properties with in situ tests
7. Perform modeling of construction performance data to help validate approach.
8. Develop methods to determine and monitor safe rate of embankment construction
9. Report findings, recommendations, procedures and technical specifications to UDOT

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $70 k

5. Indicate type of research and/or development project this is

Large: ☒ Research Project ☐ Development Project
Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
☐ Other: _____

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

Start date 7/1/07
End date 12/31/08

7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)

Laboratory test procedures
Software for modeling
Modeling Report and Validation of Approach (Report)

8B. Describe how this project will be implemented at UDOT.

This research and its deliverables will be used by UDOT geotechnical division or its design consultants to evaluate embankment performance and stability for rapid construction on soft soil sites.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be.

Reduced construction time and cost
Improved methods of analysis, design and construction performance monitoring with higher reliability
Less construction, settlement/instability risks to stakeholders, adjacent landowners and facilities

9. Describe the expected risks and obstacles as well as the strategies to overcome them.

Some of the field investigations and construction performance monitoring will need to be coordinated with UDOT construction personal and construction contractors.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

Name	Organization / Division / Region	Phone	Email
Ryan Cole	IGES / U of U		
Jim Higbee	UDOT/ Geotech		

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study: